

The background features a green-tinted image of a runner in profile, wearing a head-mounted display and carrying a backpack, running on a treadmill in a laboratory setting. The treadmill's frame and various cables are visible.

NUTRITION BASICS: MACRONUTRIENTS, MICRONUTRIENTS & HYDRATION

The Gatorade logo, a stylized white lightning bolt with grey and black accents, is positioned above the text box.

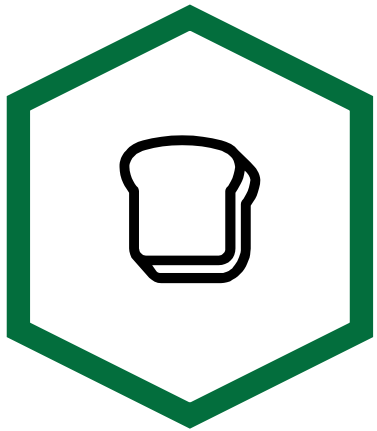
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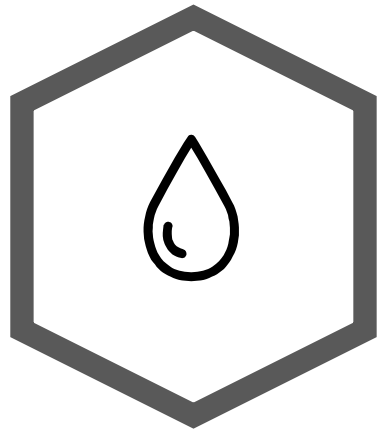
OVERVIEW

A nutrient is a chemical substance in food that contributes to the survival and growth of an organism

The 6 Nutrients we will be discussing in this introductory lecture are:



Carbohydrates



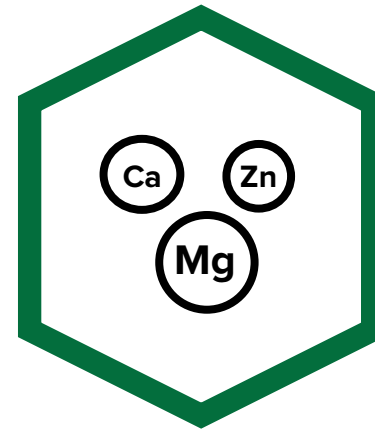
Lipids



Protein



Vitamins

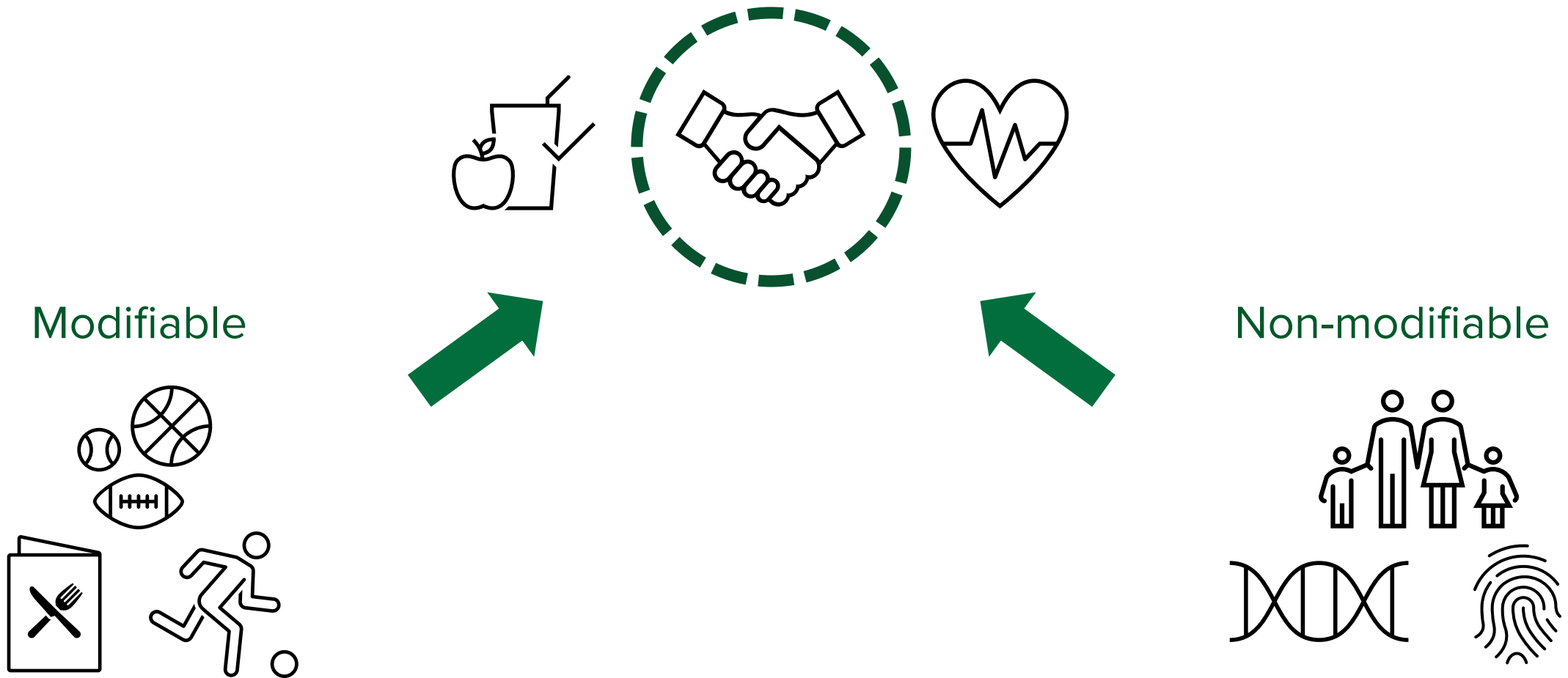


Minerals



Water

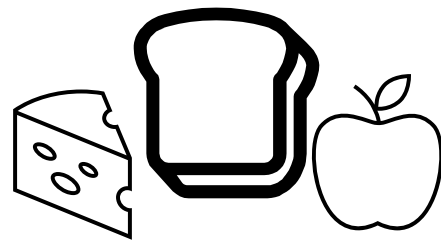
RELATIONSHIP BETWEEN NUTRITION & FITNESS



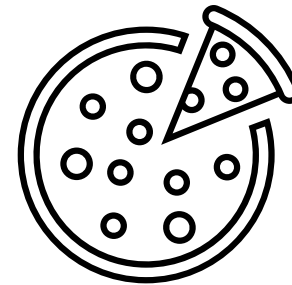
- Calories are a unit of measurement
- A measure of food energy
- Often denoted on food labels as:
 - Calories per serving
 - kcal per 100 g
- Foods provide varying levels of nutrition for their calorie content



Example:



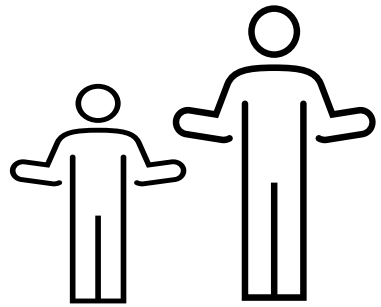
Turkey sandwich + apple +
cheese (3 cubes) = ~660 kcal



Medium Pepperoni
Pizza = ~1700 calories

CALORIE INTAKE RECOMMENDATIONS

Based on several factors:



Body
size



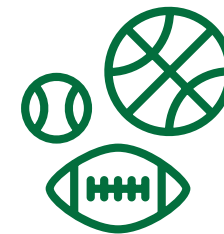
Body
composition



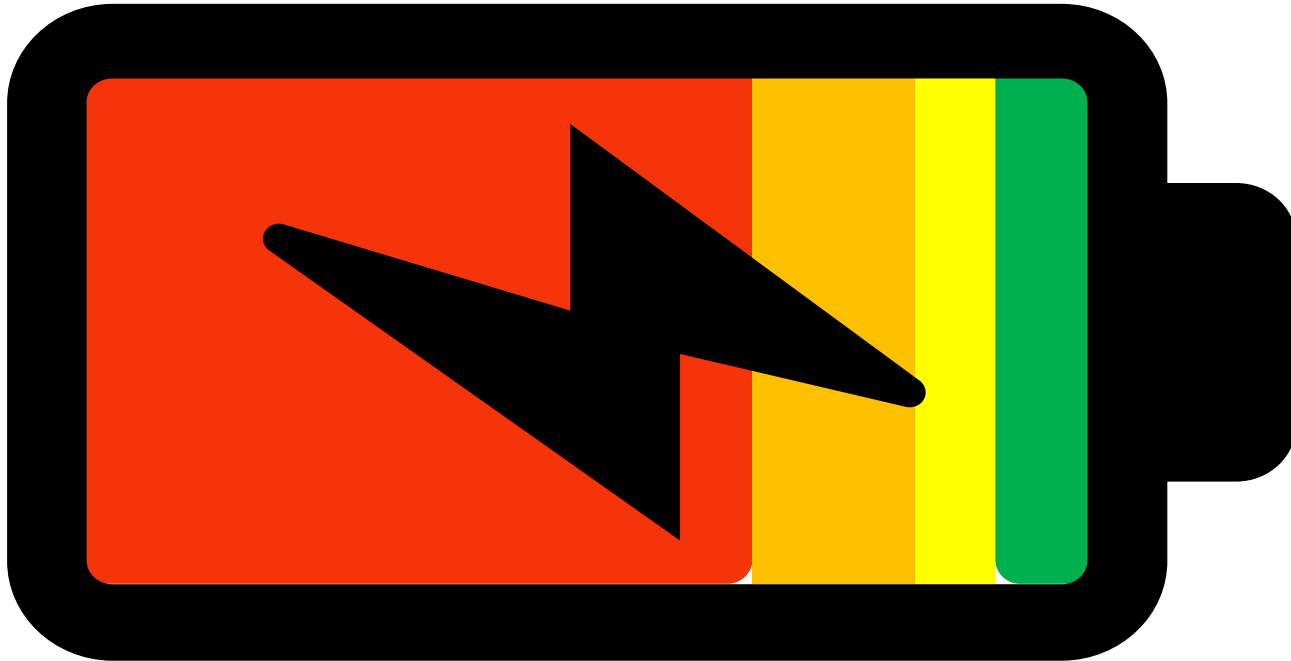
Type of
training

5-8 calories/minute
for normal activities of
daily living

Account for additional caloric
expenditure based on type and length
of training



What drains our batteries?



- Total Energy Expenditure
- 1) Resting Metabolic Rate (RMR)
 - 2) Non-Exercise Activity Thermogenesis (NEAT)
 - 3) Thermic Effect of Food (TEF)
 - 4) Exercise

Positive vs. Negative



=



Calorie Balance



<



Negative Calorie Balance
(Calorie Deficit)



>



Positive Calorie Balance
(Calorie Surplus)

READING A FOOD LABEL

Nutrition Facts	
8 servings per container	
Serving size	2/3 cup (55g)
<hr/>	
Amount per serving	
Calories	230
<hr/>	
<small>% Daily Value*</small>	
Total Fat 8g	10%
Saturated Fat 1g	5%
<i>Trans</i> Fat 0g	
Cholesterol 0mg	0%
Sodium 160mg	7%
Total Carbohydrate 37g	13%
Dietary Fiber 4g	14%
Total Sugars 12g	
Includes 10g Added Sugars	20%
Protein 3g	
<hr/>	
Vitamin D 2mcg	10%
Calcium 260mg	20%
Iron 8mg	45%
Potassium 240mg	6%
<hr/>	
<small>* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.</small>	

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Total Carbohydrate 37g 13%

Dietary Fiber 4g 14%

Total Sugars 12g

Includes 10g Added Sugars 20%

Protein 3g

Vitamin D 2mcg 10%

Calcium 260mg 20%

Iron 8mg 45%

Potassium 240mg 6%

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Amount per serving

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Total Fat 8g 10%

Saturated Fat 1g 5%

Trans Fat 0g

Cholesterol 0mg 0%

Sodium 160mg 7%

Total Carbohydrate 37g 13%

Dietary Fiber 4g 14%

Total Sugars 12g

Includes 10g Added Sugars 20%

Protein 3g

1g fat= 9 calories

1g Carb= 4 calories

1 g Protein= 4 calories

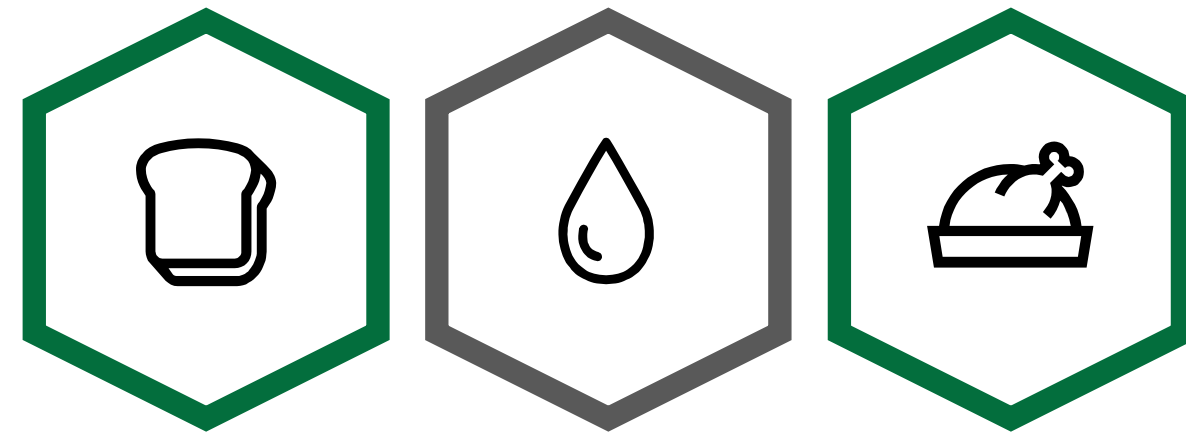
MACRONUTRIENTS & ATP

Cells cannot directly use glucose or triglycerides for energy.

Must be converted to **adenosine triphosphate (ATP)**.

Muscle can store only a small amount of ATP (2-4 seconds worth).

Muscle can also store a small amount of Pi to regenerate ATP quickly (~5 seconds).



Carbohydrates

Lipids

Protein

Can be used to make ATP

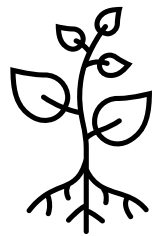
$ADP + \text{Energy from food} + P_i \rightarrow ATP$

$ATP \rightarrow \text{Energy to do work} + ADP + P_i$

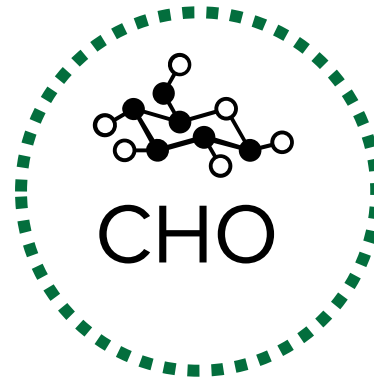
Carbohydrates = **4** calories per gram

Made up of carbon, hydrogen, and oxygen ($C_6H_{12}O_6$).

In plants



CHO = Sugars
Starches
Fibre



In the body



Glucose (in the blood)
Glycogen (in the liver
and muscle)

Carbohydrates are commonly known as a source of energy for the body.

CARBOHYDRATES - INTAKE



CHO Recommended Daily Allowance (RDA) = 130 g/day

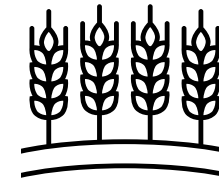


Food and Nutrition Board recommends = 45-65% of total caloric intake



Nutrition facts label uses its own standard = 60% of calories

This includes fiber:



Adequate intake (AI):

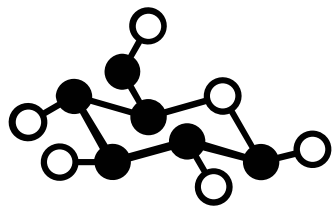
25 g/d

Women

38g/d

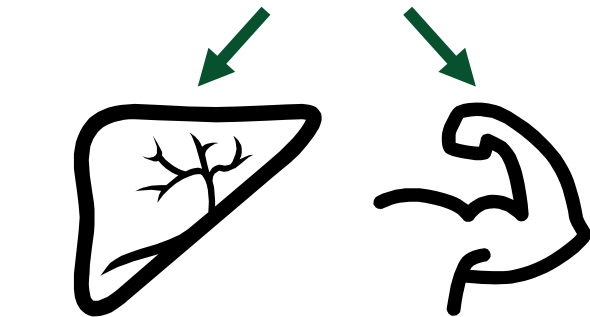
Men

CARBOHYDRATES AS FUEL FOR MUSCLE



GLUCOSE

= Most useful form of CHO fuel for muscle



Maintains blood glucose

Supplies glucose for fuel to muscles



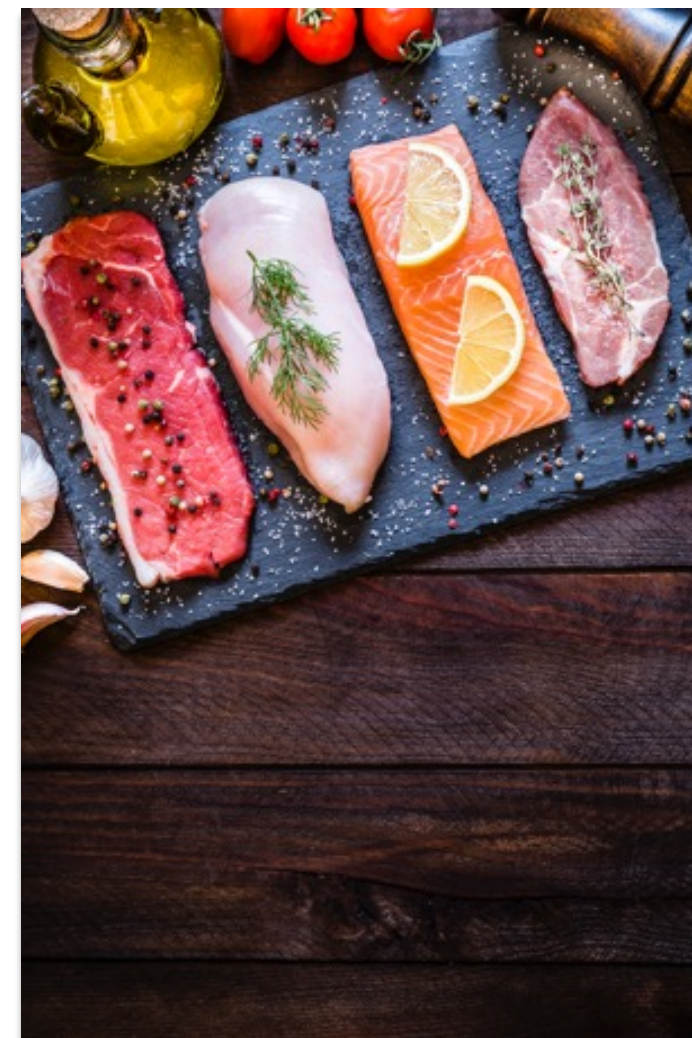
Vigorous exercise > 1 hour

=
↑ CHO needs

Protein = **4** calories per gram

Proteins are involved in:

- Blood clotting
- Fluid balance
- Hormone production
- Enzyme production
- Cell repair
- Connective tissues
- Neurotransmitters
- and many more!



PROTEIN INTAKE



Recommended Daily Allowance (RDA) = 0.8 g/kg/day



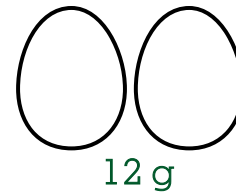
Food and Nutrition Board recommends = 10-35% of total caloric intake



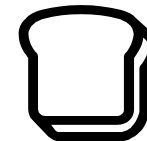
Nutrition facts label uses its own standard = % Daily value (DV) listed only if there is a high protein claim

What does 0.8 g/kg/day of protein look like?

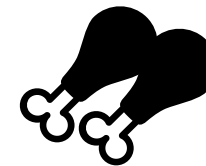
60 kg person =
48 g protein/day



12 g



8 g

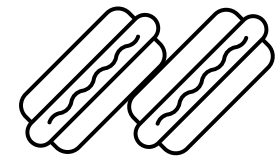


24 g

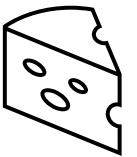


4 g

85 kg person =
68 g protein/day



18 g

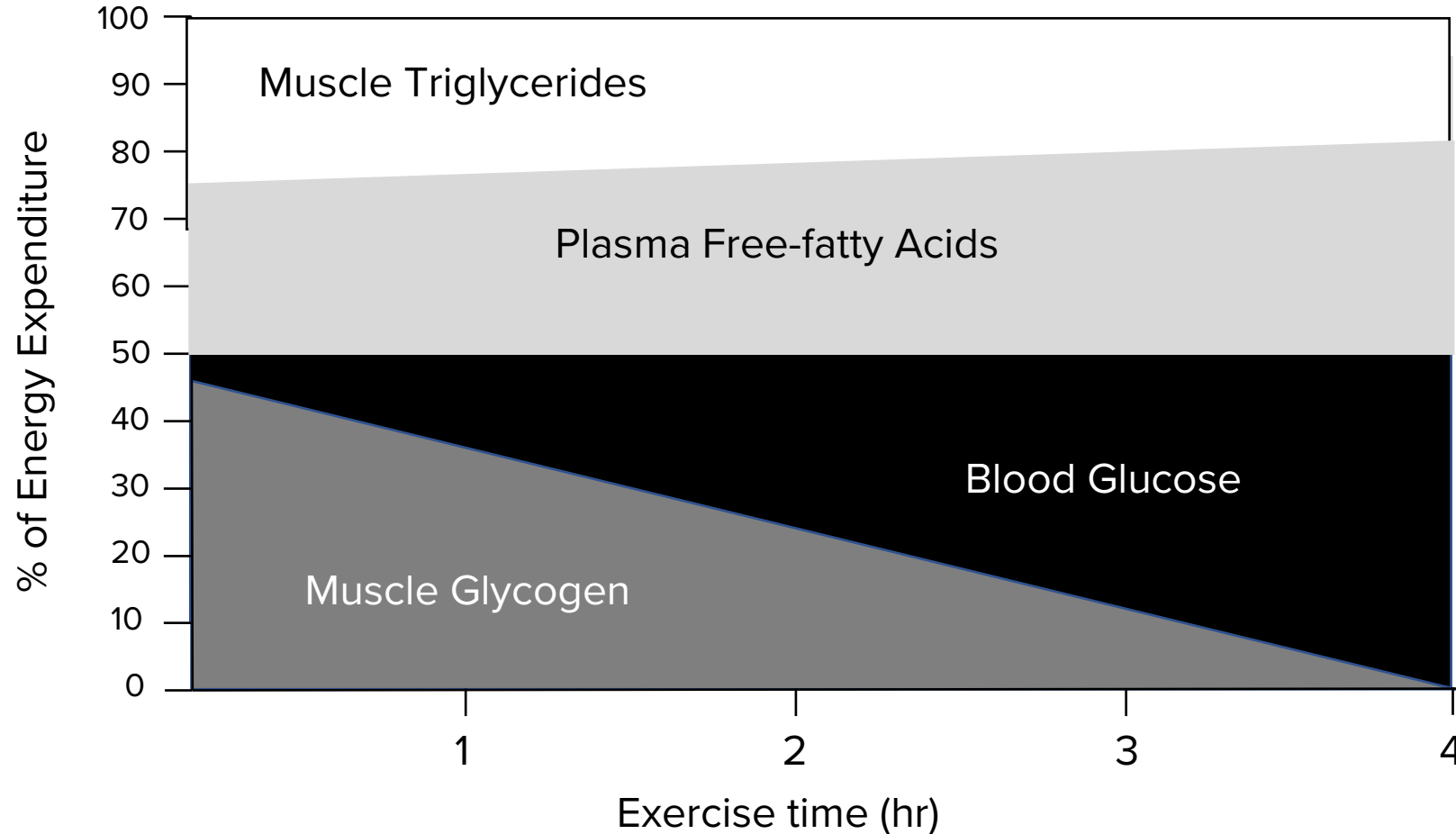


12 g



38 g

PROTEIN AS FUEL?



Protein contributes very little to fuel during exercise.

The exception to this is during prolonged endurance exercise!

Fat = **9** calories per gram

Fats serve several important functions in the body:

- Make up lipid membranes
- Help to transport vitamins
- Energy storage
- Required to produce sex hormones

Saturated fats:

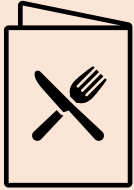
- Straight fatty acid tails
- Solid at room temperature (ex. Butter)

Unsaturated fats:

- Bent fatty acid tails (due to double bond)
- Tend to be liquid at room temperature (ex. Olive oil)

Trans fats:

- Contain trans double bonds
- Rare in nature (produced during partial hydrogenation)
- Solid at room temperature (ex. shortening)



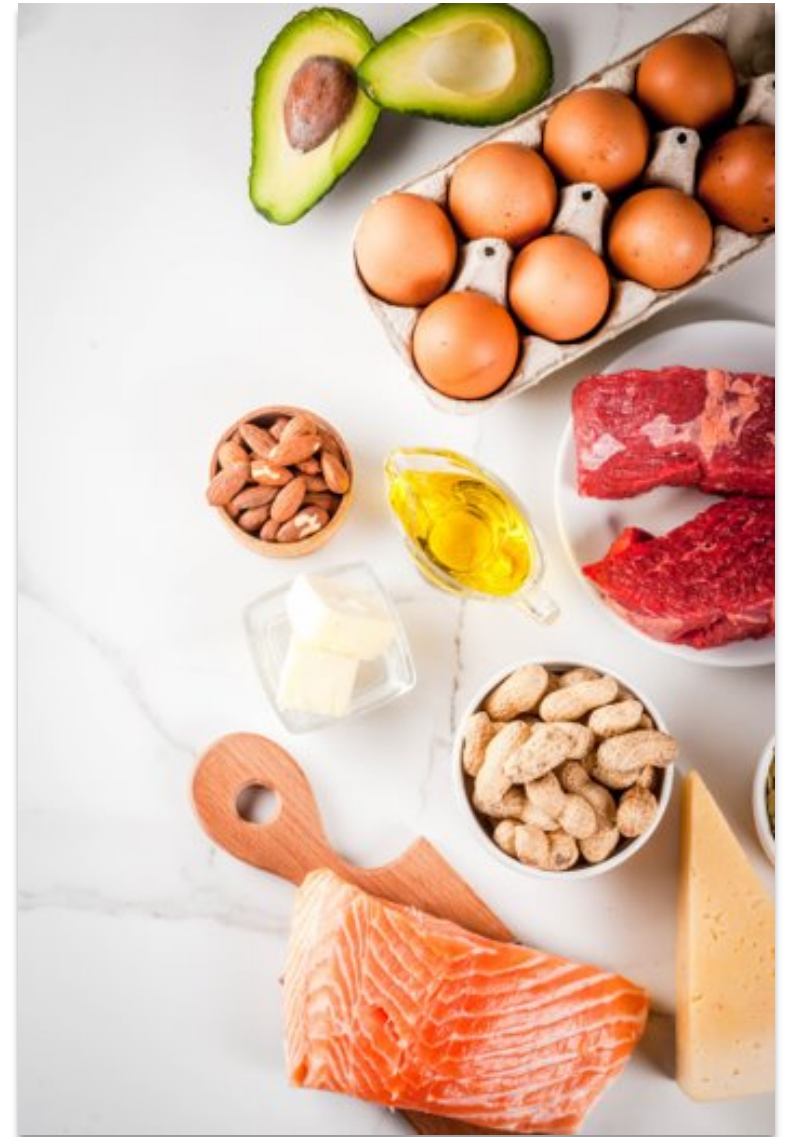
Recommended Daily Allowance (RDA) = there is **NO** RDA



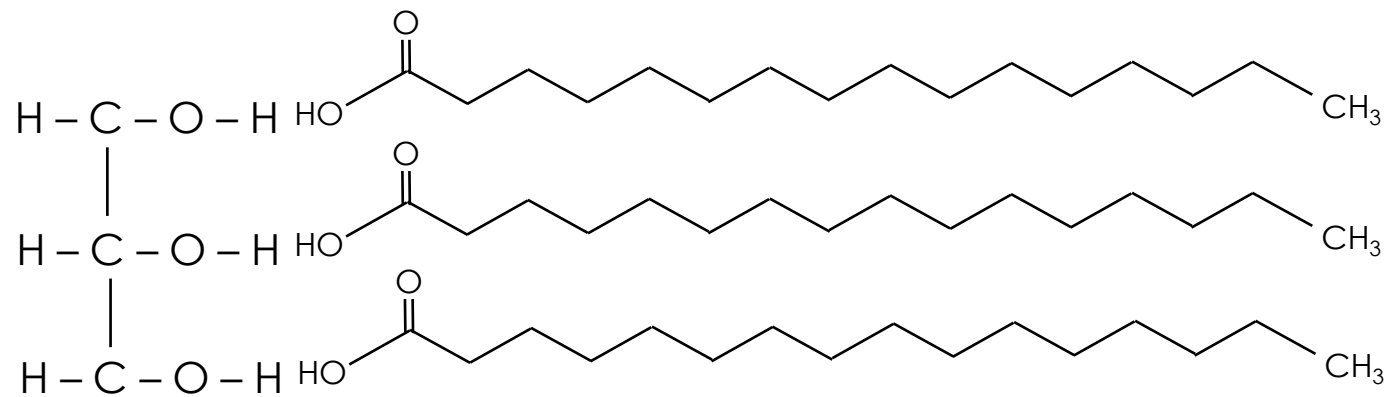
Food and Nutrition Board recommends = 20-35% of total caloric intake



Nutrition facts label uses % DV
= >20 g of saturated fat



FAT & SKELETAL MUSCLE



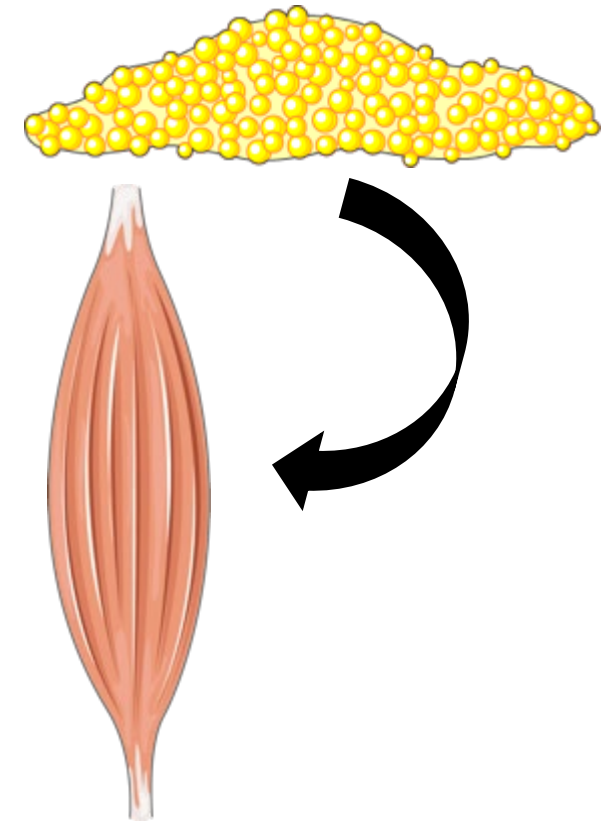
Glycerol backbone

3 Fatty Acids

Taken to the blood stream and broken down



The more fatty acids in the blood stream, the more can be taken up by muscle and used for fuel.

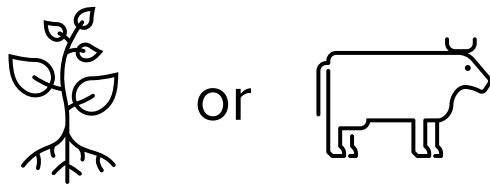


Some fat can be stored in the muscle (intramuscular triglycerides [IMTG]) to be used quickly for fuel.

Vitamins = **0** calories per gram

- Are required for normal function, growth and maintenance
- Assist in chemical reactions

Can come from:



Are categorized by solubility:



Fat

Water

In order to be classified as a vitamin:

- 1 The body is not able to synthesize enough of the nutrient to maintain health
- 2 Prolonged absence of the nutrient produces deficiency symptoms

FAT SOLUBLE VITAMINS

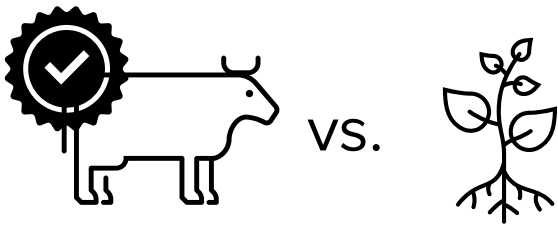
Vitamin	Major Function
Vitamin A (preformed vitamin A and provitamin A)	Promote vision: night and color; promote resistance to bacterial infection and overall immune system through mucus production; promote growth; prevent drying skin and eyes; antioxidant; acne treatment
Vitamin D	Increase absorption of calcium and phosphorus; Maintain optimal blood calcium and calcification of bone; skin development
Vitamin E	Antioxidant: prevents breakdown of vitamin A and unsaturated fatty acids; improves vitamin A absorption; metabolizes iron in cells; maintains nervous tissue and immune function
Vitamin K	Activation of blood-clotting factors, Activation of proteins involved in bone metabolism

WATER SOLUBLE VITAMINS

Vitamin	Major Function
Thiamin (vitamin B-1)	Coenzyme of carbohydrate metabolism; nerve function
Riboflavin (vitamin B-2)	Coenzyme of oxygen requiring pathways like fatty-acid breakdown, homocysteine metabolism
Niacin (vitamin B-3)	Used by almost all metabolic pathways; coenzyme of energy metabolism; makes new compounds; coenzyme of fat synthesis
Pantothenic Acid (vitamin B-5)	Coenzyme of energy metabolism from carbs, fat, and protein; coenzyme of fat synthesis; coenzyme of fat breakdown
Vitamin B-6 (pyridoxine)	Coenzyme for numerous enzymes of carb, fat, and especially in protein metabolism by splitting nitrogen group from amino acid; neurotransmitter synthesis; hemoglobin synthesis; white blood cell synthesis
Biotin (vitamin B-7)	Coenzyme of glucose production and fat synthesis by adding carbon dioxide to other compounds
Folate vitamin B-9) (folate is the natural form which contains more glutamic acid which slows absorption; folic acid is chemical form added to foods and supplements without glutamic acid, vitamin B-9)	Coenzyme involved in DNA synthesis to help form new red blood cells by supplying/accepting single carbon compounds; helps form neurotransmitters in the brain to help with depression
Vitamin B-12 (Cobalamin)	Coenzyme of folate metabolism in that it converts folate to its active form; maintains myelin sheaths to insulate neurons from each other and maintain nerve function; homocysteine metabolism
Vitamin C (Ascorbic Acid)	Collagen synthesis for connective tissue and wound healing; hormone synthesis; neurotransmitter synthesis; possible antioxidant activity; reduces destruction of folate; increases iron absorption; immune system and defense versus common cold
Choline	Part of acetylcholine which is a neurotransmitter; part of lecithin which is a phospholipid; homocysteine metabolism

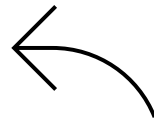
Minerals = **0** calories per gram

- The **only** inorganic nutrient
- Can function independently or as part of a mineral combination (ex. Bone minerals)



Animal sources are absorbed better than plant sources

Classified as: **Major** vs. **Trace**



Plant sources:

Contain fibre and binders (hinders absorption)

Rely on minerals from the soil (poor soil = poor plant minerals)

Refined plant foods have lower mineral contents

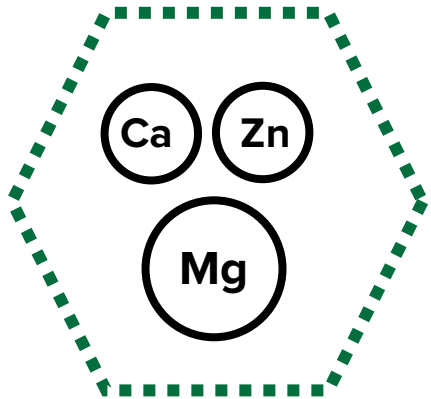
MAJOR MINERALS

Mineral	Major Functions
Sodium	Major positive ion of extracellular fluid; fluid/water balance and retention; aids nerve impulse transmission; absorption of nutrients like glucose
Potassium	Major positive ion of intracellular fluid; fluid/water balance; lowers blood pressure; aids nerve impulse transmission
Chloride	Major negative ion of extracellular fluid; fluid/water balance; participates in acid production in stomach; aids nerve impulse transmission; used by white blood cells when attack foreign cells
Calcium	Bone and tooth structure; blood clotting; aids in nerve impulse transmission; muscle contractions
Phosphorus	Major ion of intracellular fluid; bone and tooth strength (mostly found here); part of various metabolic compounds involved in energy metabolism; component of enzymes, DNA, and cell membranes
Magnesium	Bone formation; aids in over 300 enzyme functions; aids nerve and heart function; required in energy-yielding compounds like insulin
Sulfur	Part of vitamins and amino acids; aids in drug detoxification in the liver; acid/base balance

TRACE MINERALS

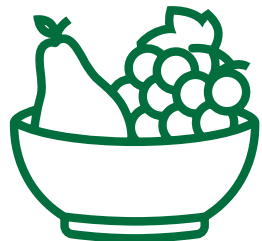
Mineral	Major Functions
Iron	Components of hemoglobin, myoglobin, and other key compounds used in respiration; part of enzymes, proteins, and compounds used in energy; immune function; cognitive development; detoxification in liver; bone health
Zinc	Required for nearly 200 enzymes; alcohol metabolism; growth; immunity; wound healing; sexual development; reproduction; antioxidant protection (component of 2 forms of superoxide dismutase); may function in reduction of macular degeneration
Selenium	Part of an antioxidant system; thyroid hormone metabolism
Iodide	Component of thyroid hormones
Copper	Involved in iron metabolism by aiding the enzyme that releases iron from storage and operates in a process that transports iron and forms hemoglobin; used in enzymes that create cross-links in connective tissue; used in enzymes that defend against free radicals (such as SOD) or other enzymes of the brain and nervous system; immune function; blood clotting; blood lipoprotein metabolism; involved with enzymes of protein metabolism and hormone synthesis
Fluoride	Increases resistance of tooth enamel against acids and bacteria that cause dental caries
Chromium	Enhances insulin action to enhance glucose uptake to cells
Manganese	Often substituted with magnesium in metabolic processes; cofactor of some enzymes such as those involved in carbohydrate metabolism; works with some antioxidant systems (such as SOD); important in bone formation
Molybdenum	Aids in action of several enzymes

VITAMINS, MINERALS & ATHLETES



Recommendations are similar to those to sedentary adults.

Athletes on **low calorie diets** (>1200 kcals) or **vegetarians** should consume fortified foods or a multi vitamin.



Antioxidant rich diets (vitamins E and C) may be beneficial for athletes.

Consume brightly colored fruits and vegetables.

WATER & HYDRATION

Water (H_2O) is the greatest component of the human body.

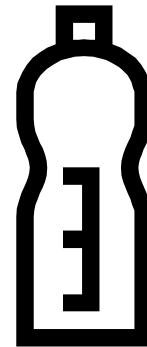
Used as a solvent in the body

Makes up approximately 50 - 70% of body mass

~ 10 gallons

~ 40 liters

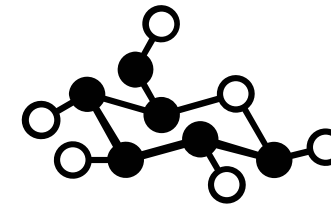
~ 165 cups of water



Muscle is 73% water

Adipose is 20% water

2.7 g of water is stored for every 1 g of glycogen



Water is a very important nutrient and has several functions in the body:

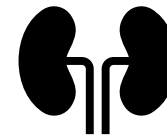
- Is a medium of chemical processes
- Transports nutrients
- Is the basis for many body fluids - especially joints (both a solvent and lubricant), saliva, and bile
- Is a medium for temperature regulation
- Aids in the removal of waste products



Water is ideal for removing body heat because it requires lots of energy to heat.



Unusable substances can be dissolved in water to be excreted.



Our kidneys are responsible for filtering out waste into urine.

KEY TAKEAWAYS

- ✓ Calories and energy come in different forms from food
 - Carbohydrate, protein and fat all provide different amounts of calories
 - Athlete requirements may be different from the general population
 - Greater energy requirements (to avoid negative energy balance)
 - Greater need for protein (repair)
 - Greater need for CHO (fuel)
- ✓ There are various types of macronutrients and micronutrients:
 - Consuming a balanced diet is the best way to ensure adequate intake
- ✓ Athletes! Don't skip on hydration!



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